Long-wave Infrared Detectors for the Planetary Infrared Spectrometers

Completed Technology Project (2015 - 2016)

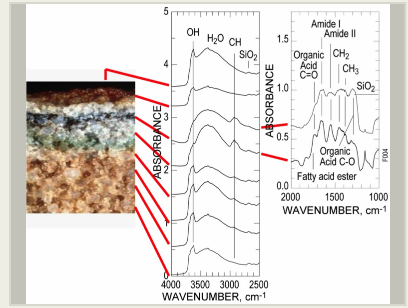
Project Introduction

Understanding the role of primitive bodies as building blocks for planets and life are key targets for space exploration. Chemical and mineralogical characterizations are critical components of this exploration. Infrared spectrometers provide a new spectroscopic capability to interrogate the feature-rich region of long-wave infrared. The objective of this work was to develop high performance in house long-wave barrier (8 μm) infrared (LWIR) detectors tailored for the use in planetary spectrometers for characterization of primitive bodies.

Currently, the major impediment for long wavelength instrumentation is the availability of sensitive detectors that can cover the region of interest – wavelengths up to approximately 7.5 μm (or wavenumbers less than ≈ 1330 cm̃1). Long-wave limits of current and recent spectrometers are 3 μm (M3), 3.92 μm (CRISM), and 5.1 μm (VIMS). While useful for hydrides (and nitriles, CO, and CO2 for VIMS), these limited ranges are unsuitable for detection and characterization of most molecules and minerals of planetary interest and especially organic molecules. As an example, while the C-H stretch band in the 3-μm region can indicate the presence of hydrocarbons, this band is not indicative of the type of chemical or functional group, i. e. alcohols, organic acids, esters, etc. Identification of these molecules requires information from other (and stronger) transitions occurring at longer wavelengths. Detection of such spectra in remote-sensing or in situ applications often requires high sensitivity long-IR detectors, particularly for diffusely reflected sunlight in outer solar system measurements. The high-quality detectors generally required for space and astronomical detectors were originally developed for the military, with the cut-off wavelengths chosen to match spectral transmission windows of the Earth's atmosphere (below 5 μm for mid-IR and above 10 μm for long-IR regions). Consequently, detectors with cut-off wavelengths between 5 and 10 μm have never been produced in quantity and are not available except expensive custom items (multi million dollars) by external vendors. The unknown detector performance of external vendors such as environmental/planet radiation increases the risk of using detectors from external providers and increases the instrument cost to verify these components under these conditions. Therefore, the costs of such detectors are in the millions of dollar range with lead times longer than one year. This is a major driver in the overall cost of spectroscopic planetary instruments and poses a significant risk to the timely and successful delivery of the instruments. Therefore, the development of an in-house detector capability at the target 8 μm wavelength with a route towards integration into planetary spectrometers takes away the risk and cost associated with external vendors and will make JPL's planetary instruments extremely competitive.

Anticipated Benefits

Flight requirement testing (radiation, and thermal cycling) raises the TRL level



Project Image Spectral measurements of Antarctic endolithic lichen community. The image at left shows a cross section of Beacon sandstone from Battleship Promontory, Antarctica. The white zone, containing a black fungus and…

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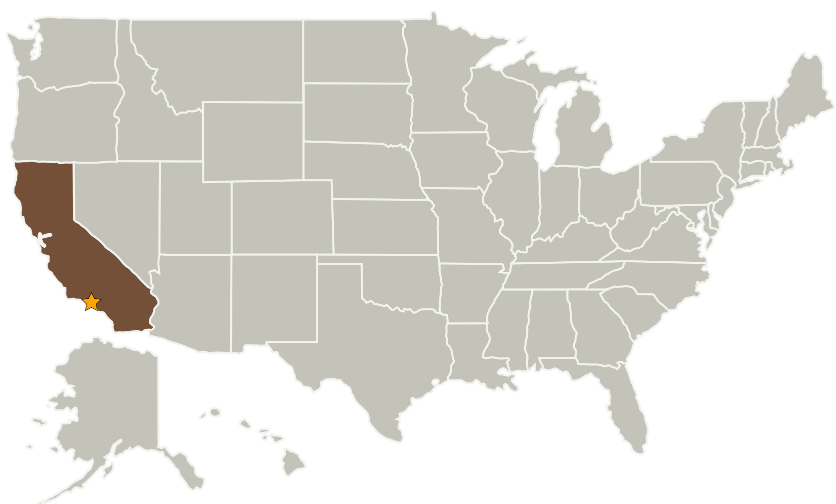
of in house barrier infrared detector technology and paves the way for infusion of this technology into future JPL/NASA instruments. This takes away the dependence of NASA/JPL instruments on expensive, custom-made, high risk and long lead time external detector vendors.

Flight qualifying in house detectors takes away the dependence of NASA/JPL instruments on expensive, custom-made, high risk and long lead time external detector vendors

This technology project will demonstrate & validate a reliable, capable, and cost effective infrared detector and focal plane array technology that can be used for commercial space ventures.

This technology project will demonstrate & validate a reliable, capable, and cost effective infrared detector and focal plane array technology that can be used on partnerships with other government agencies.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Arezou Khoshakhlagh

Co-Investigators:

Robert W Carlson
Sarath D Gunapala
Kevin P Hand

Center Independent Research & Development: JPL IRAD

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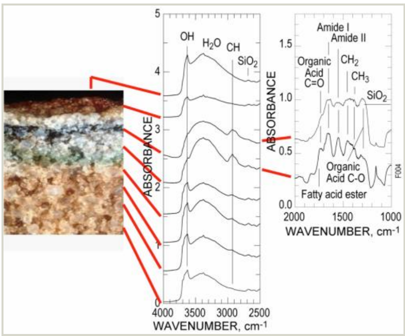
Primary U.S. Work Locations

California

Images



Long-wave Infrared Detectors for the Planetary Infrared Spectrometers Project Image

Project Image Spectral measurements of Antarctic endolithic lichen community. The image at left shows a cross section of Beacon sandstone from Battleship Promontory, Antarctica. The white zone, containing a black fungus and greenish algae, is bleached by lichen-produced oxalic acid. The middle panel shows spectra *(https://techport.nasa.gov/image/26091)*

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **4**

1 2 3 4 5 6 7 8 9

Applied Research | Development | Demo & Test

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.1 Detectors and Focal Planes